Acoustic radiation- and streaming-induced microparticle velocities determined by microparticle image velocimetry in an ultrasound symmetry plane

We present microparticle image velocimetry measurements of suspended microparticles of diameters from 0.6 to 10μm undergoing acoustophoresis in an ultrasound symmetry plane in a microchannel. The motion of the smallest particles is dominated by the Stokes drag from the induced acoustic streaming flow, while the motion of the largest particles is dominated by the acoustic radiation force. For all particle sizes we predict theoretically how much of the particle velocity is due to radiation and streaming, respectively. These predictions include corrections for particle-wall interactions and ultrasonic thermoviscous effects and match our measurements within the experimental uncertainty. Finally, we predict theoretically and confirm experimentally that the ratio between the acoustic radiation- and streaming-induced particle velocities is proportional to the actuation frequency, the acoustic contrast factor, and the square of the particle size, while it is inversely proportional to the kinematic viscosity.

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